$\bar{B}^0 \to \phi K_S$ and $\bar{K}^{*0}\gamma$ CP Asymmetries from Supersymmetric Right-handed Flavor Mixing: Implications for Heavy Quark Phenomenology

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Two recent experimental developments, when combined, may have far reaching implications. $S_{\phi K_S} < 0$, if confirmed, would imply large s-b mixing, a new CP phase, and right-handed dynamics. Large Δm_{B_s} would be likely, making the B_s program at hadron machines difficult. Reconstruction of B vertex from K_S at B factories, as shown by BaBar's first measurement of $S_{K_S\pi^0}$, makes $S_{K_S\pi^0\gamma}$ in $\bar{B} \to \bar{K}^{*0}\gamma$ accessible. This would be a boon for B factory upgrades. Supersymmetric Abelian flavor symmetry, independently motivated, can realize all of this with a light $\widetilde{sb}_1$ squark. B factory and collider studies of flavor, CP and SUSY may not be what we had expected.

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The B factories have enjoyed great success since turning on a few years ago, and luminosity upgrades are already being discussed. One critical issue is the *physics* case, especially with competition from LHCb and BTeV at hadronic machines. Two recent developments strengthen this case: the possibility that $S_{\phi K_S} < 0$, which suggests New Physics (NP); the possibility to reconstruct the B vertex from K_S at B factories, which makes $S_{K_S\pi^0\gamma}$ in $\bar{B} \to \bar{K}^{*0}\gamma$ accessible. The former may make large Δm_{B_s} hard to avoid, hence dampen the prospects for CP studies via B_s system. In contrast, $S_{K_S\pi^0\gamma}$ in $\bar{B} \to \bar{K}^{*0}\gamma$ is of great interest, as it is free from hadronic uncertainties. Taking in view the slow start of the Tevatron Run II program, a timely upgrade of B factories to $\mathcal{L} > 10^{35}$ cm^{-2}s^{-1} seems desirable.

In 2002, the B factories reported [1, 2] an indication for "wrong sign" mixing dependent CP asymmetry in $\bar{B}^0 \to \phi K_S$, i.e. $S_{\phi K_S} = -0.39 \pm 0.41$. The 2003 updates, $S_{\phi K_S} = -0.96 \pm 0.50^{+0.09}_{-0.11}$ (Belle, 140 fb^{-1} [3]), $0.45 \pm 0.43 \pm 0.07$ (BaBar, 110 fb^{-1} [4]), however, are in 2.1σ disagreement. The Belle result agrees with their previous $-0.73 \pm 0.64 \pm 0.22$ [1] using 78 fb^{-1} data, and is by itself 3.5σ away from the expected value of $\sin 2\phi_1(\beta) = 0.736 \pm 0.049$ [4]. The BaBar result, however, shifted by more than 1σ from their previous $-0.18 \pm 0.51 \pm 0.09$ [2] based on 81 fb^{-1}. Another year is needed for the issue to settle, but the 2003 average [4],

$$S_{\phi K_S} = -0.15 \pm 0.33, \tag{1}$$

is still 2.7σ away from 0.73. The new physics hint may well be real. Such a large effect would require large effective s-b mixing and a new CP phase. Furthermore [5, 6], to account for $S_{\eta' K_S} \sim \sin 2\phi_1 > 0$ as well, the new interaction should be right-handed.

In this paper we point out that a class of models with approximate Abelian flavor symmetry [7] (AFS) *and* supersymmetry (SUSY) provides all the necessary ingredients in a natural way. AFS implies near maximal s_R-b_R mixing, but has no impact with only Standard Model (SM) dynamics. With supersymmetric AFS (SAFS), however, maximal $\tilde{s}_R$-$\tilde{b}_R$ squark mixing [8, 9] brings forth a single CP phase and $s_R\tilde{b}_R\tilde{g}$ couplings.

Focusing only on the 2-3 down sector, the down quark mass matrix normalized to m_b has the elements $\hat{M}^{(d)}_{33} \simeq 1$, $\hat{M}^{(d)}_{22} \simeq \lambda^2$, where $\lambda \cong 0.22$. Taking analogy with $V_{cb} \simeq \lambda^2$ gives $\hat{M}^{(d)}_{23} \simeq \lambda^2$ also, but $\hat{M}^{(d)}_{32}$ is unknown for lack of right-handed flavor dynamics. With effective AFS [7], however, the *Abelian* nature implies $\hat{M}^{(d)}_{23}\hat{M}^{(d)}_{32} \sim \hat{M}^{(d)}_{33}\hat{M}^{(d)}_{22}$, hence $\hat{M}^{(d)}_{32} \sim 1 \sim \hat{M}^{(d)}_{33}$. This may be the largest off-diagonal term but its effect is hidden within SM. In SAFS, the flavor mixing extends to $\tilde{s}_R$-$\tilde{b}_R$ squarks, which can be parametrized as

$$\widetilde{M}^{2(sb)}_{RR} = \begin{bmatrix} \widetilde{m}^2_{22} & \widetilde{m}^2_{23}e^{-i\sigma} \\ \widetilde{m}^2_{23}e^{i\sigma} & \widetilde{m}^2_{33} \end{bmatrix} \equiv R \begin{bmatrix} \widetilde{m}^2_1 & 0 \\ 0 & \widetilde{m}^2_2 \end{bmatrix} R^\dagger, \tag{2}$$

where $\widetilde{m}^2_{ij} \sim \widetilde{m}^2$, the squark mass scale, and

$$R = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta e^{i\sigma} & \cos\theta e^{i\sigma} \end{bmatrix}, \tag{3}$$

diagonalizes $\widetilde{M}^{2(sb)}_{RR}$. There is just one [9] CP phase σ, which is on equal footing with the KM phase δ as both are rooted in the quark mass matrix. Note that $(\widetilde{M}^2)_{LR} = (\widetilde{M}^2)^\dagger_{RL} \sim \widetilde{m}M$ is suppressed by quark mass, while $(\widetilde{M}^2)_{LL}$ is CKM suppressed.

Our interest is phenomenological rather than model building. With strong hint for new physics CP violation in $S_{\phi K_S} < 0$, where else can effects be large? A realistic model such as SAFS allows us to be comprehensive and make more definitive predictions. Together with a recent demonstration [4] of B decay vertex finding with K_S, we arrive at a surprising result: the B_d system, rather than B_s, may be more accessible for probing CP violation in $b \to s$ transitions induced by $\tilde{s}_R$-$\tilde{b}_R$ mixing.

Low energy constraints are serious. Even after decoupling the d flavor [9], stringent kaon constraints imply

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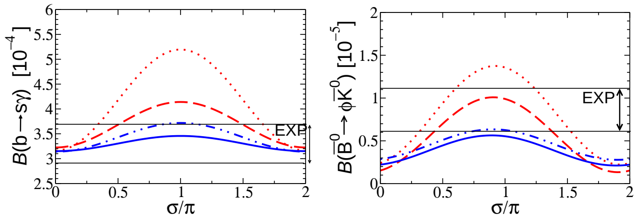

FIG. 1: (a) $\mathcal{B}(b \to s\gamma)$ and (b) $\mathcal{B}(B^0 \to \phi K^0)$ vs σ for $\widetilde{m}_1 = 200$ GeV compared with experiment. Solid, dotdash (dash, dots) lines are for $\widetilde{m} = 2$, 1 TeV, $m_{\tilde{g}} = 0.8$ (0.5) TeV.

that $\widetilde{m}$ and $m_{\tilde{g}}$ to be TeV scale or higher. We enforce $\widetilde{m}_{22}^2 \cong \widetilde{m}_{23}^2 \cong \widetilde{m}_{32}^2 \cong \widetilde{m}_{33}^2 \cong \widetilde{m}^2 \gtrsim$ TeV. By some amount of fine-tuning [9], one can have a light "strange-beauty" squark $\widetilde{sb}_1$ to enhance the impact on $b \leftrightarrow s$ transitions. We shall see that, $S_{\phi K_S} < 0$ requires $\widetilde{sb}_1$ to be light, and the gluino to be not too heavy.

To compute short distance coefficients, we use mass basis of Eq. (2) rather than mass insertions, since off-diagonal elements are large. Hadronic amplitudes are calculated in naive factorization, since the aim is to explore new physics effects. Details cannot be given here, but $O_{3-6}^{(\prime)}$, $O_{7,8}^{(\prime)}$ and $O_{9,10}^{(\prime)}$ operators arise from the strong, electromagnetic (EM) and electroweak (EW) or Z penguins, respectively, while special attention would be paid to $O_{11,12}^{(\prime)}$, the EM and chromo-dipole penguins. The prime indicates purely new physics effects arising from right-handed dynamics.

For illustrations, we shall take $\widetilde{m}_1 \simeq 200$ GeV, $\widetilde{m}$ at 1, 2 TeV and $m_{\tilde{g}} = 0.5$, 0.8 TeV. One still survives [9] the $b \to s\gamma$ constraint, as shown in Fig. 1(a), where we use $\mathcal{B}(b \to s\gamma) = (3.14 \times 10^{-4})(|c_{11}|^2 + |c_{11}'|^2)/|c_{11}^{\rm SM}|^2$ with $c_{11}^{\rm SM} \simeq -0.31$. For $\sigma \sim \pi$, one has constructive LR chiral enhancement effect. Otherwise, RR effect dominates and $b \to s\gamma$ is very forgiving. We see that $b \to s\gamma$ is an effective constraint on LR mixing.

The $\bar{B} \to \phi K_S$ decay amplitude is

$$\mathcal{A}(\bar{B}^0 \to \phi \bar{K}^0) \propto \left\{ \cdots + \frac{\alpha_s}{4\pi} \frac{m_b^2}{q^2} \, \tilde{S}_{\phi K} \, (c_{12} + c_{12}') \right\}, \quad (4)$$

where $\cdots$ are several terms $\propto a_i + a_i'$, and q is the virtual gluon momentum. It turns out that only c_{12}' is sensitive to the $\widetilde{sb}_i$-$\tilde{g}$ loop. The SM strong penguin already has a large logarithm, while the Z-penguin receives large m_t effect. The rate, plotted in Fig. 1(b), is compatible with data. Comparing with Fig. 1(a), we note that for $m_{\tilde{g}} = 0.5$ TeV, the $b \to s\gamma$ and $B \to \phi K_S$ rates balance each other at $\sigma \sim 65^\circ$, 300°. This is supported by CP violating data, which further selects the former branch.

As shown in Fig. 2(a), for $\sigma \sim 40^\circ$–90°, large $\tilde{s}_R$-$\tilde{b}_R$ mixing can indeed [5, 10] turn $S_{\phi K_S}$ negative, while for $\sigma \sim 180^\circ$–360°, it is larger than the SM value of 0.73. With $\widetilde{m}_1$ held fixed, there is little difference between $\widetilde{m} =$

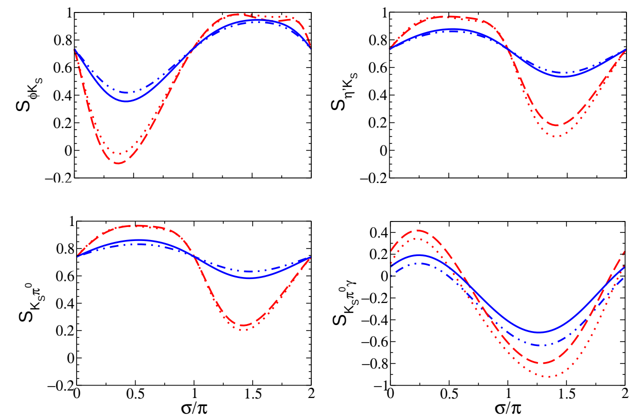

FIG. 2: (a) $S_{\phi K_S}$, (b) $S_{\eta' K_S}$, (c) $S_{K_S\pi^0}$ and (d) $S_{K_S\pi^0\gamma}(\bar{B}^0 \to \bar{K}^{*0}\gamma)$ vs σ with notation as in Fig. 1.

1 and 2 TeV. The effect weakens for $\widetilde{m}_1 > 200$ GeV, but for lighter $\widetilde{m}_1$, e.g. 100 GeV, the change is not dramatic. This is why we chose $\widetilde{m}_1 = 200$ GeV. Although $m_{\tilde{g}} \lesssim 500$ GeV is preferred, lowering $m_{\tilde{g}}$ further can lead to trouble with low energy constraints. However, two hadronic parameters, $\tilde{S}_{\phi K}$ and q^2, accompany c_{12}'. The former arises from evaluating the matrix element of $O_{12}^{(\prime)}$ and may be larger than the naive factorization result of $\tilde{S}_{\phi K} = -1.3$. For the latter, $q^2 < m_b^2/3$ is possible (within $m_b^2/2 \gtrsim q^2 \gtrsim m_b^2/4$ [11]). Thus, $m_{\tilde{g}} < 500$ GeV may not be needed if $m_b^2\,|\tilde{S}_{\phi K}|/q^2 > 3.9$. Our parameter choice has been in part to reflect Eq. (1), the current average central value for $S_{\phi K}$.

Eq. (1) is also opposite in sign with respect to [3] $\bar{B} \to \eta' K_S$ which is also dominantly $b \to s$ penguin [12]. The large rate for this mode is not well understood, which the $\widetilde{sb}_1$ squark does not help to explain. However, the effect on $S_{\eta' K_S}$ anticorrelates [5, 6] with $S_{\phi K_S}$. As illustrated in Fig. 2(b), for $S_{\phi K_S} < 0$, one has $S_{\eta' K_S} \gtrsim 0.73$ which is consistent with experiment. This is traced to the c_{12}' dependence in decay amplitude,

$$\mathcal{A}(\bar{B}^0 \to \eta' \bar{K}^0) \propto \left\{ \cdots + \frac{\alpha_s}{4\pi} \frac{m_b^2}{q^2} \, \tilde{S}_{\eta' K} \, (c_{12} - c_{12}') \right\}. \quad (5)$$

The $\cdots$ are many terms $\propto a_i - a_i'$. Even the $c_{12} - c_{12}'$ term has two terms, i.e. $\tilde{S}_{\eta' K}^{(d)} = -1.5$ and $\tilde{S}_{\eta' K}^{(s)} = -3.6$ for $B \to \eta'$, K transitions, respectively. Compared to Eq. (4), the primed terms change sign because, in contrast to the vector current production of ϕ, current production of pseudoscalars distinguishes the sign of the axial part of $V \mp A$ current.

We see that the right-handed strange-beauty squark $\widetilde{sb}_1$ can generate the CP effects observed in $\bar{B} \to \phi K_S$ vs $\bar{B} \to \eta' K_S$. It is interesting that $\sigma \sim 65^\circ$ agrees quite well with what is inferred from Fig. 1 with rates. Note that the hadronic parameter $\tilde{S}_{\eta' K_S}$ is more involved

than $\tilde{S}_{\phi K_S}$. The extra hadronic effects needed to enhance $B \to \eta' K_S$ would also likely dilute [5] the impact of the $\widetilde{sb}_1$-$\tilde{g}$ loop, unless the latter is an active ingredient. Thus, Fig. 2(b) is only illustrative.

Direct CP asymmetries ($A_{\rm CP}$) are very sensitive to hadronic phases, but they are of great interest. Keeping only perturbative penguin phases, for $(\widetilde{m}_1,\ \widetilde{m},\ m_{\tilde{g}}) = (0.2,\ 1,\ 0.5)$ TeV, we find $A_{\phi K_S} \sim +0.21$ and $A_{\eta' K_S} \sim -0.22$. The current average [13] for the former (latter) is slightly positive (negative), though still consistent with zero. More interesting is $A_{\rm CP}(K^-\pi^+)$, where the current average [13] of -0.09 ± 0.03 is getting significant. We find $A_{\rm CP}(K^-\pi^+) \simeq A_{\rm CP}(K^-\pi^0)$ drops from $+0.12$ to -0.02 for $\sigma \sim 0$–$75°$, which improves upon the positive value in QCD factorization. There is currently a disagreement between Belle and BaBar on $A_{\rm CP}(K^-\pi^0)$, giving a zero average, but $A_{\rm CP}(\bar{K}^0\pi^+) \sim -0.15$ and $A_{K_S\pi^0} \equiv A_{\rm CP}(\bar{K}^0\pi^0) \sim -0.2$ for $\sigma \simeq 65°$ are also not inconsistent with data. In fact, BaBar finds [4] $C_{K_S\pi^0} \equiv -A_{K_S\pi^0} = +0.40^{+0.27}_{-0.28} \pm 0.10$, giving $A_{K_S\pi^0} < 0$.

The $\widetilde{sb}_1$ loop clearly improves the agreement with current experimental trend of $A_{\rm CP}$s, and the effect can be enhanced by the hadronic parameter $\tilde{S}/q^2$. It is important to stress *the need for right-handed interactions*. Had the new physics been in the left-handed sector, such that c_{11} is enhanced but c'_{11} remains negligible, then $A_{\rm CP}(\phi K)$ would track the sign of $A_{\rm CP}(K\pi)$ [14]. The same holds for $S_{\phi K_S}$ vs $S_{\eta' K_S}$, $S_{K_S\pi^0}$.

The aforementioned $C_{K_S\pi^0}$ measurement is done by an exciting new method from BaBar [4]. By extrapolating the K_S momentum onto the boost axis (e^- direction), *which is the B direction*, one can determine the B decay vertex. The $\bar{B}^0 \to K_S\pi^0$ mode had looked formidable, since $\pi^0 \to \gamma\gamma$ leaves no track, while $K_S \to \pi^+\pi^-$ typically decays outside the silicon vertex detector. BaBar has clearly benefitted from a larger vertex detector with more layers, but analysis details are not yet available. In view of possible future development, we plot $S_{K_S\pi^0}$ vs σ in Fig. 2(c). The prediction of $S_{K_S\pi^0} > 0.73$ is similar to $S_{\eta' K_S}$ since both have PP final states, and is consistent with $S_{K_S\pi^0} = 0.48^{+0.38}_{-0.47} \pm 0.10$ from BaBar [4].

The implication of the new BaBar method goes beyond hadronic final states. "Wrong helicity" photons from $b \to s\gamma$ decay would indicate new physics, which can be probed [15, 16] by mixing dependent CP violation in exclusive radiative $\bar{B}^0$ decays,

$$S_{M^0\gamma} = \frac{2|c_{11}c'_{11}|}{|c_{11}|^2 + |c'_{11}|^2}\,\xi\,\sin\left(2\phi_{B_d} - \varphi_{11} - \varphi'_{11}\right), \qquad (6)$$

where ξ is the CP of reconstructed M^0 final state, and $\phi_{B_d} = \phi_1$, $\varphi^{(\prime)}_{11}$ are the CP phases of B_d mixing and $c^{(\prime)}_{11}$, respectively. Both photon helicities must be present for $\bar{B}^0$ and B^0 decay amplitudes to interfere. In SM which is purely left-handed, c'_{11} hence $S_{M^0\gamma}$ vanishes with light quark mass. Thus, $S_{K^{*0}\gamma}$ is a good probe of new physics,

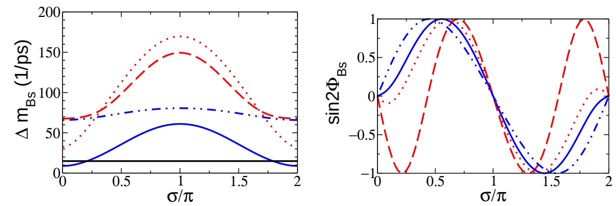

FIG. 3: (a) Δm_{B_s} and (b) $\sin 2\Phi_{B_s}$ vs σ with notation as in Fig. 1. The horizontal line is current bound on Δm_{B_s}.

if it can be measured. It is exciting that the BaBar technique makes this promising via $K^{*0} \to K_S\pi^0$. Lack of a vertex in $\bar{B}^0 \to \bar{K}^{*0}\gamma$ has heretofore prompted us to consider the rarer $\bar{B}^0 \to \rho^0\gamma$, $\bar{K}_1(1270)^0\gamma$ (both not yet seen), $\phi K_S\gamma$, or wait for $B^0_s \to \phi\gamma$.

Eq. (6) shows that $S_{K^{*0}\gamma}$ is free from hadronic effects that plague the hadronic modes of Fig. 2(a)–(c). The $B \to K^*$ form factor drops out from the ratio that gives $S_{K^{*0}\gamma}$. We stress that $c^{(\prime)}_{11}$, $\varphi^{(\prime)}_{11}$ and hence $S_{K_S\pi^0\gamma}$ are calculable within the present framework. For our parameter values, $\sin 2\theta \equiv 2|c_{11}c'_{11}|/(|c_{11}|^2 + |c'_{11}|^2) \sim 0.15$ to 1 for $\sigma \sim 0$ to π (2π to π), and is finite. For $\bar{B}^0 \to \bar{K}^{*0}\gamma$, we plot $S_{K_S\pi^0\gamma}$ vs σ in Fig. 2(d). For $\sigma \sim 65°$ as favored by $S_{\phi K_S} \lesssim 0$, we see that $S_{K_S\pi^0\gamma} \sim 0.2$–$0.3$ is expected. *The measurement of this confirming effect should be pursued with vigor at B factories.* We remark that $b \to s\ell^+\ell^-$ rate is unaffected, since the Z penguin correction is suppressed by LR mixing. But c'_{11} can be probed by the forward-backward asymmetry for very low m_{ee} when $c^{(\prime)}_{11}$ is dominant.

Two of us have emphasized [9] B_s mixing and CP violation as good places to look for the effect of $\widetilde{sb}_1$, with Δm_{B_s} just above present bound of 14.9 ps^{-1} [17] as most interesting. However, the large effect of $S_{\phi K_S} < 0$ calls for rather light $\widetilde{sb}_1$ and $\tilde{g}$, and we see from Fig. 3(a) that *$\Delta m_{B_s} \gtrsim 70$ ps^{-1} is hard to avoid.* We believe this is a generic feature, not just a consequence within SAFS. Basically, the LR mixing possibility is constrained by $b \to s\gamma$, hence $S_{\phi K_S}$ and Δm_{B_s} are closely linked. Measurement of $\Delta m_{B_s} \gtrsim 70$ ps^{-1} at Tevatron Run II is basically hopeless, and would be challenging even for LHCb and BTeV. Although $\sin 2\Phi_{B_s}$ (Fig. 3(b)) can still be measured together with Δm_{B_s}, the very fast B_s oscillations would make CP studies in B_s system such as $B_s \to D_S K$ very challenging.

It is intriguing that $S_{\phi K_S} < 0$ implies very large Δm_{B_s} mixing and finite $\sin 2\Phi_{B_s}$, but they push the limits of current vertexing technology and the CP program in B_s system looks difficult. Modes such as $\bar{B}_s \to \phi\gamma$ for wrong helicity photon study, and all the hadronic modes in analogy to those of $\bar{B}_d$ decay, such as $\bar{B}_s \to \phi\eta'$, become difficult. In contrast, $\bar{B}_d$ decays become more revealing as we have illustrated, and luminosity upgrades to B factories

would be desirable. Premium should be put on a larger silicon vertex detector. Note that $S_{K_S\pi^0\gamma}$ measurement may be unique to B factories, both for the precision electromagnetic calorimetry, and because one knows the B direction. It is also more important since it is free from hadronic parameters.

The $\Lambda_b \to \Lambda\gamma$ decay is still unique to hadronic machines. It can also probe [16, 18] wrong helicity photons, since Λ is expected to keep the polarization of the s quark. The effect is measured via the angular parameter α_Λ (= 1 in SM), where hadronic effects are also absent. We find $\alpha_\Lambda \sim 0.6$ for $(\widetilde{m}_1,\ \widetilde{m},\ m_{\tilde{g}}) = (0.2,\ 1,\ 0.5)$ TeV, and drops with $m_{\tilde{g}}$.

Our minimal picture has 3 parameters: $\widetilde{m}_1 \lesssim 200$ GeV, $m_{\tilde{g}} \lesssim 500$ GeV, and $\sigma \sim 65°$, with all other SUSY partners (except a dominantly bino $\widetilde{\chi}_1^0$) $\gtrsim$ TeV scale. One still needs collider input since B decays give only indirect information. Direct search for the light $\widetilde{sb}_1$ squark would be imperative. In general [9], one has to take into consideration the presence of both $\widetilde{sb}_1 \to b\widetilde{\chi}_1^0$ and $s\widetilde{\chi}_1^0$ which would dilute the b-tagging effectiveness. The situation for the Tevatron is not clear, but it should not be a problem for LHC. A combined study at B factories and colliders should be able to determine the flavor and CP violating SUSY model parameters.

We stress before closing the importance of low energy constraints, as well as the need for TeV scale SUSY in face of large flavor violation. It was pointed out [19] recently that the s-quark chromoelectric dipole moment is related to the $b \to s$ color dipole by $\tilde{s}_L$-$\tilde{b}_L$ mixing insertion. We have $\tilde{s}_L$-$\tilde{b}_L$ mixing $\sim \lambda^2$ and cannot evade this constraint, which applies to all models. There are, however, even more hadronic uncertainties here. Second, a generic feature of quark-squark alignment (QSA) models [7] is D^0-$\bar{D}^0$ mixing generated by relegating $V_{us} \simeq \lambda$ to up-type quarks. Assuming up-type squarks are also at 1–2 TeV, we typically get $x_D \sim 7\%$ (11%–20%) for $m_{\tilde{g}} = 800$ (500) GeV, which should be compared with the bound of $x_D \equiv \Delta m_D/\Gamma_D \lesssim 2.9\%$ [17]. This makes a 500 GeV gluino problematic, and is a reminder of flavor or family interrelations in a realistic setting. Work on D^0 mixing in QSA models should be refined, and D^0 mixing should clearly be searched for.

Finally, maximal ν_μ-ν_τ mixing may [20] be related to right-handed $\tilde{s}_R$-$\tilde{b}_R$ mixing in SUSY GUT framework. While this adds to the attraction of a light strange-beauty squark, it involves extra dynamical assumptions at very high scale (including right-handed neutrino mass). Our working scale has been TeV and below, and based on observed flavor patterns.

In summary, $S_{\phi K_S} < 0$, if confirmed, would require large s-b mixing with new CP phase and right-handed dynamics. B_s mixing would likely be large and the B_s program becomes difficult. On the other hand, $S_{K_S\pi^0\gamma} \neq 0$ in $\bar{B}^0 \to \bar{K}^{*0}\gamma$ is likely, and one now has good prospect for measurement at B factories. A three parameter minimal model can generate all these effects. Although SUSY is above TeV scale, the model has 1) a right-handed, flavor-mixed "strange-beauty" squark $\widetilde{sb}_1$ below 200 GeV, 2) one new CP phase, and 3) $m_{\tilde{g}} \lesssim 500$ GeV. It has independent motivation from quark mass and mixing patterns with an underlying effective Abelian flavor symmetry. Luminosity upgrades of existing B factories would be very worthwhile, and a combined study with colliders can determine model parameters.

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